

# Simulation Study of a Futsal Ball Deformation in Normal Impact Using Finite Element Method

Fabian Halley Pata Anak Alban Dattu, Syed Tarmizi Syed Shazali, Magdalene Andrew-Munot, Abang Mohamad Aizuddin Abang Mohamad Mohtar, and Noor Hisyam Bin Noor Mohamed

**Abstract**—The popularity of the futsal games has gradually increased since it was introduced in Uruguay. Since that, the futsal games became a medium for the young players to train to be professional footballers. Many coaches are avoiding heading tactic until they are 12 years of age. This technique can lead into the potential cause of traumatic brain injury. To date there has been no study to predict the deformation of the futsal ball in normal impact on flat surface at low speeds. The purpose of this study is to investigate the deformation behavior of the futsal ball upon impact. The free fall drop test is performed on the futsal ball size 4 when hitting a rigid target at different heights 500mm, 1,000mm, and 1,500mm. The result shows that, the higher ball drop, the higher deformation of the ball. Then, a finite element model (FEM) of a futsal ball was constructed and the simulation of the ball analysis was done by comparison between two materials, which were Butyl Rubber (IIR) and Latex Rubber (NR). The results show that, the Butyl Rubber is the better material for futsal ball construction, as there are less deformation and stress which is in allowable stress. However, further improvement needs to be done by taking into consideration of the futsal ball under large deformation as well as at a high impact.

**Index Terms**—Futsal ball, deformation, impact analysis, finite element modelling.

## I. INTRODUCTION

Futsal game originated from Uruguay in 1936 and the name of futsal was named by FIFA, which is simply a mixture of the Spanish words for 'hall' (sala) and 'Football' (futbol) then formed the futsal [1]. The game of futsal allows young people to create and expand many skills and mastery that are transferable to the 11-a-side games. Many of the top world class footballers played futsal in their youth and credit it to enhance their football playing skills, example are Pele, Kaka, and Lionel Messi.

The history of futsal in Malaysia started by the year 1990, but it is still not the favourite sport compared to other sports such as badminton and football. However, in the middle 2000 futsal had drastically become the favourite among the youth because it is easier to play and do not need many players compared to football that needs a wide range of field and a lot of players. Futsal was also well received not only amongst men, but also received encouraging response from the women.

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The authors are with the Universiti Malaysia Sarawak, Faculty of Engineering, and Malaysia (e-mail: bentebelian@gmail.com, starmizi@unimas.my, ammagdal@unimas.my, amaizuddin@unimas.my, nmnhisyam@unimas.my).

In addition, the response from the adult and the elderly is also very favourable compared to football.

In futsal games, player will obtain the ball more frequently than they do in playing football. This required the players to perform more individual techniques and required more repetitions on the games and this contribute impact between the ball and the players during the games. Past researcher such as, D.S Price, R. Jones and A. R. Harland had been conducted the research on soccer ball. Their research was to determine the mechanical properties of the soccer ball [2]. Previous researcher such as K. Tanaka and Brian J.M were more focused on the research on dynamic properties of golf and baseball. Both had determined the deformation on that sport balls by conducting the impact test [3].

Thus, the most prevalent test experiment on the sports ball is by conducting a drop test. The drop test is usually used to determine the dynamic characteristic of the sports ball. Finite Element Analysis (FEA) is an interesting method to simulate the model and to compare and collect the mechanical properties used for a material selection. This method is mostly applied in the design process, to minimize the time process and perform better materials selection.

The aim of this research is to investigate the Finite Element Model (FEM) of futsal ball size 4. The model of the futsal ball size 4 was used to perform FE analysis with two different types of material, which are butyl and latex. Deformations of the futsal ball are the parameter of interest for the measured in the analysis.

### A. Problem Statement

Futsal as a game played by both gender physically brings a player into a standard one-on-one situation with essential fast kicking skill and requires heading. Since this sport is a repetition contact games, many coaches are avoiding tactic of heading until aged of 12 [4]. Compared to other contact sport, head and neck injuries reportedly have contributed 4% to 22% of all injuries in soccer. A head injury is a traumatic injury to the head that is usually evident on clinical examination by the head impact [5]. Two thirds of most soccer players may experience symptoms of head injuries over one full year of soccer participation. Heading involves repeated impact, acceleration-deceleration of the brain inside the skull, and possibly rotation of the brain [6].

### B. Objectives of the Study

This research was conducted to investigate the deformation impact of futsal ball size 4 on different heights of a ball release. To achieve these objectives, major aims are addressed in this research:

- a) To determine the deformation of futsal ball size 4 by performing the drop test.